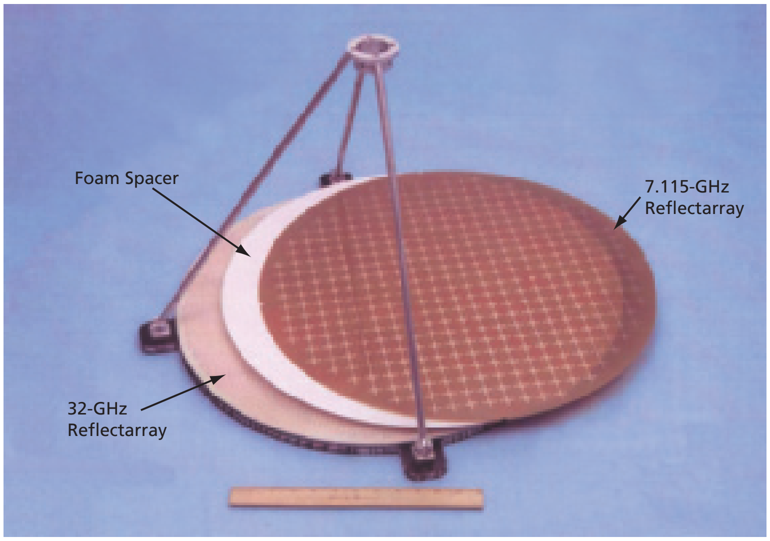
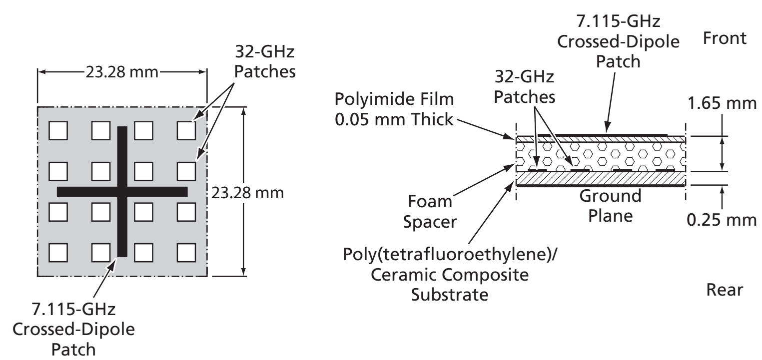


PHOTOGRAPH SHOWING DUAL-BAND REFLECTARRAY ANTENNA PARTLY DISASSEMBLED



MAGNIFIED TOP VIEW OF A UNIT CELL

MAGNIFIED CROSS SECTION OF A UNIT CELL

Two Reflectarrays for Different Frequency Bands are sandwiched together with a dielectric foam spacer to form a single dual-band reflectarray.

A reflectarray antenna consists mainly of a planar array of microstrip patches on a suitable dielectric substrate. In a prototype of the dual-band reflectarray antenna (see figure), the 7.115-GHz reflectarray antenna consists of crossed dipole microstrip patches on a thin polyimide membrane; the 32-GHz reflectarray antenna consists of square microstrip patches on top and a ground plane on the bottom of a poly(tetrafluoroethylene)/ceramic composite substrate. The ground plane is bonded to a supporting aluminum plate. The 7.115-GHz reflectarray is placed in front, and the two reflectarrays are sandwiched together with a dielectric foam spacer between them. The crossed-dipole patches of the front (7.115-GHz) reflectarray are positioned between the square patches of the rear (32-GHz) reflectarray to minimize blockage of radiation from the rear array.

In tests of the prototype antenna, it was found that the front (7.115-GHz reflectarray) caused a 1.8-dB reduction in the 32-GHz gain, while the effect of the rear (32-GHz) reflectarray on the 7.115-GHz performance was negligible. It was also concluded, on the basis of the test data, that there is a need to refine understanding of interactions between the individual reflectarrays and to refine their designs accordingly.

This work was done by Mark Zawadzki and John Huang of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).
NPO-40689

Opto-Electronic Oscillator Using Suppressed Phase Modulation

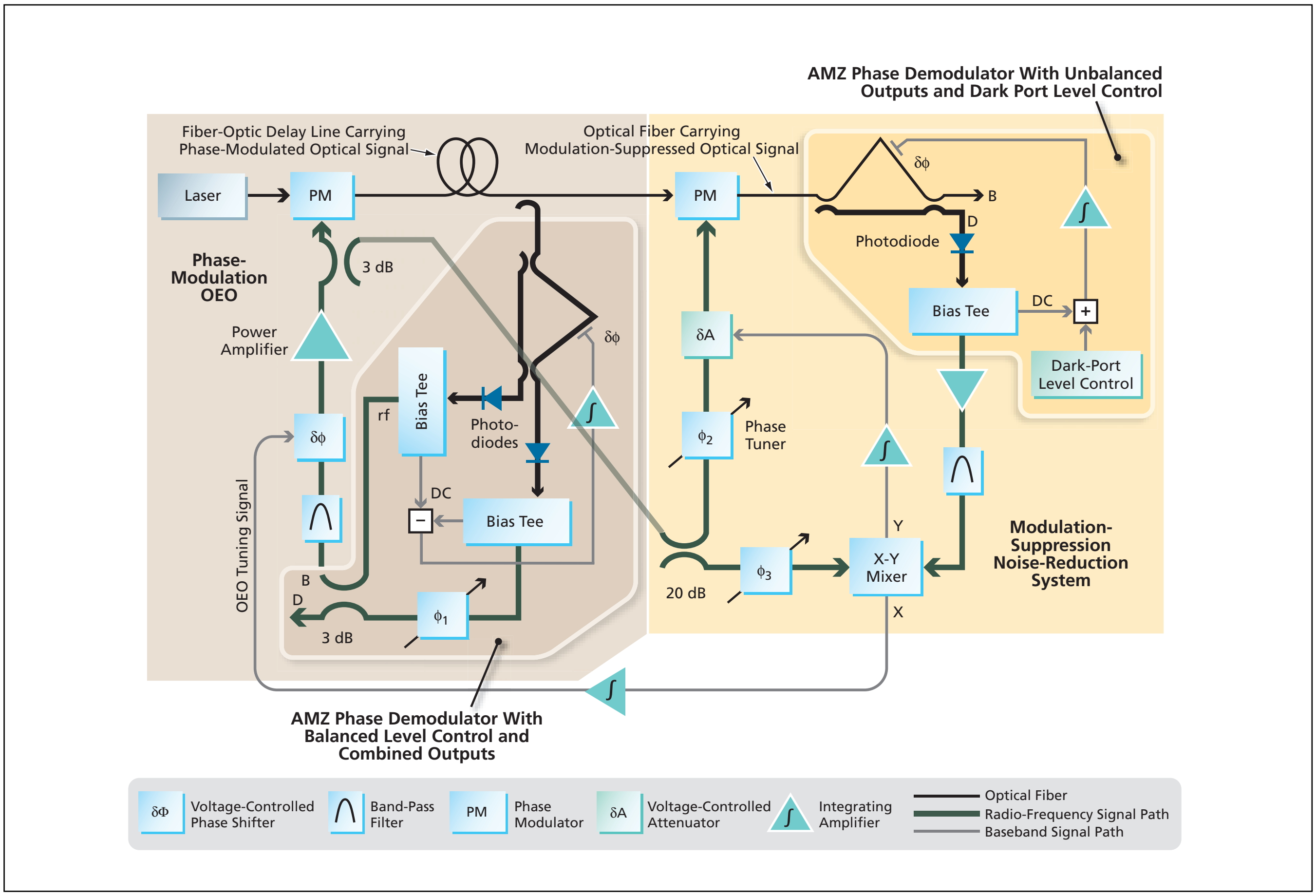
Phase noise would be much lower than in prior OEOs.

NASA's Jet Propulsion Laboratory, Pasadena, California

A proposed opto-electronic oscillator (OEO) would generate a microwave signal having degrees of frequency stability and spectral purity greater than those achieved in prior OEOs. The design of this system provides for reduction of noise levels (including the level of phase noise in the final output microwave signal) to below some of the fundamental limits of the prior OEOs while retaining the advantages of photonic generation of microwaves. Whereas prior OEOs utilize optical amplitude modulation, this system would utilize a combination of optical phase modulation and suppression thereof. The design promises to afford, in the opto-electronic domain, the low-noise advantages of suppression of carrier signals in all-electronic microwave oscillators.

OEOs that utilize suppression of radio-frequency carrier signals have already been demonstrated to reject amplifier flicker noise. However, a second important advantage of microwave carrier suppression — reduction of the effects of thermal noise or shot noise (photon-counting noise) — has not previously been realized in OEOs. In microwave applications, realization of this advantage is made possible by (1) use, in oscillators or interferometers, of power levels higher than can be tolerated by a low-noise follower amplifier, combined with (2) means for reducing power levels at detectors while preserving sensitivity. In the proposed system, realization of this advantage would be made possible by notable aspects of the design that would enable the use of high optical power levels to reduce shot-noise-induced variation in the frequency of an OEO.

The proposed system (see figure) would include two subsystems: a phase-



This **Modulation-Suppressed OEO** would generate a microwave signal having a degree of spectral purity higher than those of prior OEOs.

modulation OEO and a modulation-suppression noise-reduction subsystem. Each subsystem would contain an asymmetric Mach-Zehnder (AMZ) phase demodulator, which would be a combination of an AMZ interferometer with voltage-controlled phase tuning in one arm, and a photodiode at either or both of two optical output ports. The length differential between the two arms is approximately matched to one half of the wavelength of the radio-frequency (RF) modulation signal, typically 1.5 cm for an X-band (10-GHz) modulation signal. With appropriate choice of delays and of phase shifts (φ_1, φ_2, φ_3), the AMZ in the modulation-suppression noise-reduction system would couple almost all of the optical power to a termination at one of its output ports, denoted the bright port and labeled "B" in the figure. The small remaining portion of the optical power, in the form a suppressed-carrier signal, would be coupled to a low-noise photodiode at the other port, denoted the dark port and labeled "D" in the figure. This arrangement would afford high sensitivity, at the photodiode output, to input phase modulation.

Sideband amplitude would also be reduced before detection by use of a phase "un-modulator" — a second phase modulator, at the output end of the fiber-optic delay line, that would exert an approximation of the reverse of the effect of the phase modulator at the input end of the line. Thus, both the carrier and the sideband components of the optical signal arriving at the low-noise photodiode in the AMZ phase demodulator in the modulation-suppression noise-reduction subsystem would be suppressed, thereby helping to prevent overload of the low-noise photodiode as optical power is increased. (Prevention of overload is necessary for preservation of sensitivity because low-noise photodiodes saturate at low optical power levels.)

This work was done by G. John Dick and Nan Yu of Caltech for NASA's Jet Propulsion Laboratory. For further information, contact iaoffice@jpl.nasa.gov. NPO-42815

Alternative Controller for a Fiber-Optic Switch

This controller communicates via a serial instead of a parallel port.

NASA's Jet Propulsion Laboratory, Pasadena, California

The figure is a simplified diagram of a relatively inexpensive controller for a DiCon VX (or equivalent) fiber-optic switch — an electromechanically actuated switch for optically connecting one or two input optical fibers to any of a number of output optical fibers. DiCon VX fiber-optic switches are used primarily in research and development in the telecommunication industry. This controller can control any such switch having up to 32 output channels.